

Monthly Progress Report

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Pursuant to: RCRA I-88-1088

Facility Site: Cranston, RI

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1.0 SUMMARY

This is the eleventh monthly progress report. Seven significant events occurred this month. These events are summarized in this section and discussed in detail in later sections of this report.

Round 1 Analyses (Task 5.7). Geotechnical analysis of the Round 1 soil and sediment samples was completed; reduction and interpretation of other field data continued.

Round 2 Analyses (Task 5.13). Chemical analyses of Round 2 samples continued; geotechnical analyses of Round 2 soil and sediment samples continued. A report describing the bioassay results from the Round 2 sediment samples was completed (Attachment A).

Round 2 Data Validation (Task 5.14). Validation of Round 2 data began.

Interim Report (Task 7). Drafting selected sections of the Phase I Interim Report continued; the authoring team met on 5/3/91 to review the status of developing the Phase I Interim Report and Phase II Proposal.

Project Management (Task 9). A meeting with the USEPA, CIBA-GEIGY Corporation, Woodward-Clyde Consultants, and IT Corporation was held on 5/24/91 to discuss project issues.

Water Level Monitoring. Monthly groundwater level monitoring continued.

Phase IA Report. The USEPA granted conditional approval (pending required revisions) of the Phase IA Report on 5/7/91; revision of the report began.

*As agreed, the reporting period will be monthly through the fourth Friday of the month.



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2.0 TASKS AND ACTIVITIES COMPLETED

The sampling and other activities (subtasks) that were completed are reported here.

2.1 Sampling Activities Completed

All Phase I sampling activities have been completed.

2.2 Other Activities Completed

Other activities (subtasks) were completed within several tasks.

Round 1 Analyses (Task 5.7). Geotechnical analysis of the Round 1 soil and sediment samples was completed.

Round 2 Analyses (Task 5.13). A report describing the bioassay results from the Round 2 sediment samples was completed.

Interim Report (Task 7). The authoring team met on 5/3/91 to review the status of developing the Phase I Interim Report and Phase II Proposal.

Project Management (Task 9). A meeting with the USEPA, CIBA-GEIGY Corporation, Woodward-Clyde Consultants, and IT Corporation was held on 5/24/91 to discuss project issues.

Phase IA Report. The USEPA granted conditional approval (pending required revisions) of the Phase IA Report on 5/7/91.

3.0 JEOPARDY TASKS (scheduled tasks not completed)

No tasks were in jeopardy as of 24 May 1991.

4.0 OTHER TASKS UNDERWAY (and on schedule)

The tasks that were underway (and on schedule as of 24 May 1991) are reported here.

Round 1 Analyses (Task 5.7). Reduction and interpretation of field data continued.

Round 2 Analyses (Task 5.13). Chemical analyses of Round 2 samples continued; geotechnical analyses of Round 2 soil and sediment samples continued.

Round 2 Data Validation (Task 5.14). Validation of Round 2 data began.

Interim Report (Task 7). Drafting selected sections of the Phase I Interim Report continued.

Water Level Monitoring. Monthly groundwater level monitoring continued.

Phase IA Report. Revision of the Phase IA Report began.

5.0 DATA OBTAINED

The sampling results and other data obtained are reported here.

5.1 Sampling Results

Analytical laboratory data for selected Round 2 samples have been received but have not yet been validated; preliminary geotechnical data for selected Round 1 samples have been received but have not yet been peer reviewed. The bioassay results from the Round 2 sediment samples are presented in Attachment A.

5.2 Other Data Obtained

Groundwater level data have been obtained but have not yet been peer reviewed.

6.0 PROBLEM AREAS

The resolved, new, potential (i.e., anticipated or possible), and outstanding (i.e., still unresolved) problem areas are reported here.

6.1 Resolved Problem Areas

No problem areas were resolved during this reporting period.

6.2 New Problem Area

One new problem area was identified and resolved during this reporting period.

Geotechnical Analyses of Samples Delayed

Review of the Problem. Samples from both Rounds 1 and 2 had been submitted for immediate geotechnical analysis at the newly selected geotechnical laboratory; the laboratory delayed returning the results for the Round 1 samples beyond the date originally agreed upon.

Resolution. The results were delayed only one week, so the schedule for developing the Phase I Interim Report was not affected.

6.3 Potential Problem Areas

No potential problem areas were identified during this reporting period.

6.4 Outstanding Problem Areas

No problem areas remained unresolved during this reporting period.

7.0 SCHEDULE OF TASKS (next two months)

The projected schedule (based on Figure 5-2 in Volume 1, Chapter 2 of the *RCRA Facility Investigation Proposal*) is provided here. It covers the tasks to be performed in the next two months (June and July 1991), along with other comments or considerations.

Target Date	Task#	Task	Comments/Considerations
7/24/91	5.13	Round 2 Analyses	
7/24/91	5.14	Round 2 Data Validation	
6/10/91	8	May Progress Report	
ongoing	9	Project Management	
ongoing	10	Data Management	
ongoing	11	Project Administration	
ongoing	12	Quality Assurance	
ongoing	13	Health & Safety Assurance	

8.0 CHANGES IN WORK PLAN

No changes to the Work Plan were made during this reporting period.

9.0 OTHER COMMENTS

The plans going forward into June and July include:

- reducing and validating the Phase I data, and
- continuing to develop the Phase I Interim Report and Phase II Proposal.

The following document is attached:

- Attachment A — Bioassay of the Toxicity of Sediments Collected from the Pawtuxet River near the Former Facility of the CIBA-GEIGY Corporation at Cranston, Rhode Island

ATTACHMENT A

Bioassay of the Toxicity of Sediments Collected from the Pawtuxet River near the Former Facility of the CIBA-GEIGY Corporation at Cranston, Rhode Island

**BIOASSAY OF THE TOXICITY OF SEDIMENTS
COLLECTED FROM THE PAWTUXET RIVER
NEAR THE FORMER MANUFACTURING FACILITY OF
CIBA-GEIGY CORPORATION AT CRANSTON, RHODE ISLAND**

Prepared by:

**IT Corporation
Knoxville, Tennessee**

JUNE 1991

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ACRONYMS

AOC	Area of Concern
AAOI	Additional Area of Investigation
EPA	U.S. Environmental Protection Agency
IT	IT Corporation
PA	Production Area
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RVR	Round Valley Reservoir
SWMU	Solid Waste Management Unit
WA	Warwick Area
WWTA	Wastewater Treatment Area

1.0 INTRODUCTION

The test results reported here are part of Phase IB of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) being undertaken at the former CIBA-GEIGY Corporation (CIBA-GEIGY) manufacturing facility in Cranston, Rhode Island (the site).

1.1 SITE DESCRIPTION AND HISTORY

The former CIBA-GEIGY facility is located in the communities of Cranston and Warwick, Rhode Island. The site is divided into three areas: the Production Area, the Wastewater Treatment Area, and the Warwick Area. The first two areas are north of the Pawtuxet River. The Warwick Area is south of the river (see Figures 1 and 2). Twelve Solid Waste Management Units (SWMUs), two Areas of Concern (AOCs), and two Additional Areas of Investigation (AAOIs) have been identified as locations of former production facilities, waste treatment or waste storage sites, locations of documented spills, or areas of historical releases of hazardous substances (Table 1).

1.2 PURPOSE OF BIOASSAY TESTING

This bioassay testing was conducted as part of Phase IB of the RFI to aid in identifying toxic characteristics of sediments in the Pawtuxet River. Bioassays reported here were intended to confirm selected results of prior bioassays, to delineate toxicity of sediments near the Production Area, and to characterize the toxicity of the sediments between the facility reach and the furthest downstream samples from the first round of bioassays.

1.3 APPROACH

Results of bioassay tests conducted on samples collected in Round 1 indicated that surface water was not toxic to the fathead minnow, *Pimephales promelas*, or to the water flea, *Ceriodaphnia dubia*. Four of six sediment samples collected within the facility reach in Round 1 were toxic to larvae of *Chironomus tentans* in a bioassay involving direct contact with the sediment. Interstitial pore water from two of these six sediment samples were toxic to *Ceriodaphnia dubia*. Based on these results, the most sensitive organism for detecting toxicity was determined to be the second instar larva of *C. tentans* and this organism was selected for use in Round 2 testing.

FIGURE 1

Locations of Sediment Samples Collected for Bioassay from the Pawtuxet River Within the Reach of the Former CIBA-GEIGY Facility at Cranston, Rhode Island

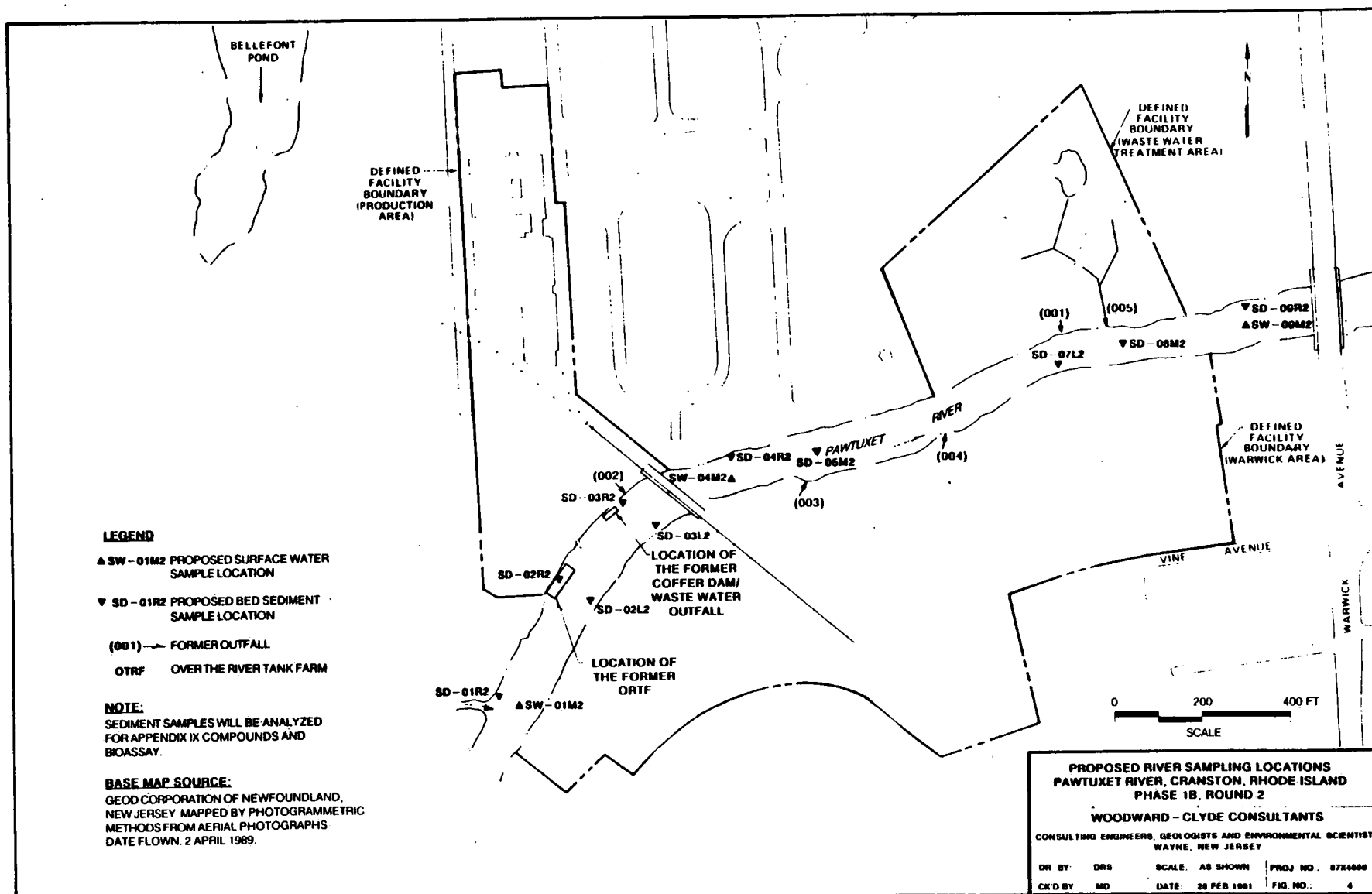


FIGURE 2

Locations of Sediment Samples Collected for Bioassay from the Pawtuxet River Beyond the Reach of the Former CIBA-GEIGY Facility at Cranston, Rhode Island.

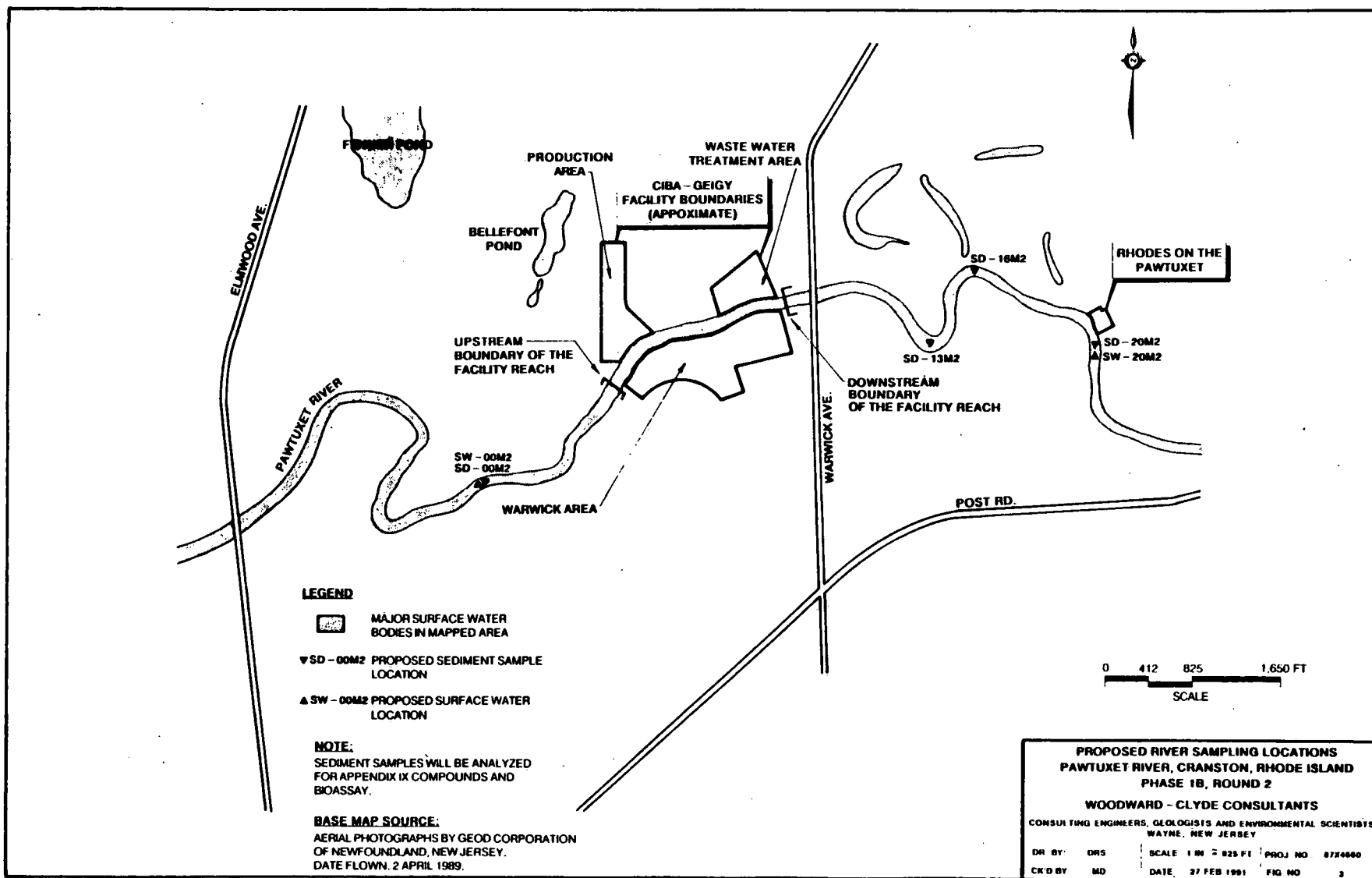


Table 1
Solid Waste Management Units, Areas of Concern, and
Additional Areas of Investigation

Area	Description	Location
SWMU-1 ^a	Hazardous waste storage area	WA ^b
SWMU-2	Hazardous waste storage area	PA ^c
SWMU-3	Hazardous waste storage area	PA
SWMU-4	Trash compactor station	PA
SWMU-5	River sediment storage area	WA
SWMU-6	Zinc oxide/soil pile	WA
SWMU-7	Chlorosulfonic acid spill area	PA
SWMU-8	Prussian Blue spill area	PA
SWMU-9	Wastewater pipeline break	WA
SWMU-10	Wastewater pipeline break	WWTA ^d
SWMU-11	Toluene waste water release	PA
SWMU-12	Waste water treatment area	WWTA
AOC-13 ^e	Process buildings	PA
AOC-14	Atlantic Tubing and Rubber Company	West of PA
AAOI-15 ^f	Laboratory building waste water sump	North of PA
AAOI-16	Maintenance department cleaning area	WA

- a. SWMU - Solid Waste Management Unit.
- b. WA - Warwick Area.
- c. PA - Production Area.
- d. WWTA - Wastewater Treatment Area.
- e. AOC - Area of Concern.
- f. AAOI - Additional Area of Investigation.

2.0 METHODS

Fourteen sediment sampling stations in the region of the former CIBA-GEIGY facility were selected for testing in Round 2 of Phase IB. Two of these stations were upstream of the facility reach: SD-00L and SD-01R. Eight stations were located along the facility reach: SD-02R, SD-02L, SD-03R, SD-03L, SD-04R, SD-05M, SD-07L, and SD-08M. The remaining four stations were downstream of the facility reach: SD-09R, SD-13R, SD-16L, and SD-20M. These stations were chosen for their proximity to facility outfalls and past releases, to confirm results from Round 1, or to delineate further the areas of toxicity found in Round 1. Sampling locations are shown in Figures 1 and 2.

Details are presented in Appendix A for transport and handling of samples, culturing of test organisms, bioassay test methodology, and statistical methods to analyze the test results. The Standard Operating Procedure (SOP) for the bioassay tests is presented in Appendix B.

3.0 RESULTS

3.1 SAMPLE DESCRIPTIONS

Physical descriptions of the sediment samples are summarized in Table 2. The sediment samples collected ranged in consistency from coarse sand to silt. The two furthest downstream samples, SD-16L and SD-20M, were coarse sand. The sample collected at the furthest downstream station along the facility reach, SD-08M, was medium sand. The sample collected off the Warwick Area between the Production Area and the Wastewater Treatment Area, SD-05M was medium sand. The sediment collected immediately upstream of the facility, SD-01R, was fine sand. Other samples contained varying amounts of silt.

3.2 BIOASSAYS

Results of the ten-day acute bioassays of sediment using *C. tentans* are shown in Table 3. Survival among organisms exposed to the reference sediment fell in the expected range of ≥ 80 percent. Survival among test organisms exposed to sediments from both upstream stations was

Table 2
Physical Description of Sediment Samples Collected near the
Former CIBA-GEIGY Facility at Cranston, Rhode Island

Sample	Physical Description
SD-00L	Silty fine sand
SD-01R	Fine sand
SD-02R	Sandy silt
SD-02L	Sandy silt
SD-03R	Silt
SD-03L	Silty fine sand
SD-04R	Sandy silt
SD-05M	Fine-medium sand
SD-07L	Silty fine sand
SD-08M	Medium sand
SD-09R	Fine sand
SD-13R	Silty fine sand
SD-16L	Medium-coarse sand
SD-20M	Coarse sand

Table 3

**Ten-Day Acute Bioassay of Sediment Collected Near the Former CIBA-GEIGY Facility
at Cranston, Rhode Island During Phase IB, Round 2 Sampling,
Using Larvae of the Midge, *Chironomus tentans***

Station Location	Mean Survival ^a (%)	Standard Deviation (%)
Reference Sediment	97.5	5.0
SD-00L	88.8	13.2
SD-01R	80.0	4.0
SD-02R	1.3 ^{b,c,d}	2.5
SD-02L	0.0 ^{b,c,d}	0.0
SD-03R	0.0 ^{b,c,d}	0.0
SD-03L	98.8	2.5
SD-04R	0.0 ^{b,c,d}	0.0
SD-05M	25.0 ^{b,c,d}	7.1
SD-07L	20.0 ^{b,c,d}	7.1
SD-08M	53.8 ^{b,c}	25.6
SD-09R	30.0 ^{b,c,d}	19.6
SD-13R	70.0 ^b	21.6
SD-16L	43.8 ^{b,c,d}	14.9
SD-20M	0.0 ^{b,c,d}	0.0

- a. n = 4 chambers, 20 organisms/chamber
- b. Significantly different from reference sediment.
- c. Significantly different from SD-00L.
- d. Significantly different from SD-01R.

somewhat lower than that seen with the reference sediment, but these differences were not statistically significant.

Essentially total mortality of test organisms occurred at four of the eight locations along the facility reach, SD-02R, SD-02L, SD-03R, and SD-04R. In contrast, virtually no mortality was seen in response to sediment from station SD-03L. Survival among chironomids exposed to sediment from stations SD-05M, SD-07L, and SD-08M was 25.0, 20.0, and 53.8 percent, respectively. These results were significantly lower than those seen with the far upstream control, SD-00L. Also, results at SD-05M and SD-07L were significantly lower than the near upstream control, SD-01R.

Exposure of test organisms to sediments from downstream stations SD-09R, SD-13R, and SD-16L resulted in intermediate survival values of 30.0, 70.0, and 43.8 percent, respectively. The results at stations SD-09R and SD-16L were significantly lower than those seen at both upstream control locations, while the result at SD-13R was not significantly different from either upstream control. Sediments from the furthest downstream station, SD-20M, caused total mortality of exposed chironomids.

4.0 DISCUSSION

Bioassays of sediment using *C. tentans* resulted in higher survival in reference sediment and upstream controls, compared to results of bioassays of Round 1 samples (Table 4). Survival of chironomids exposed to Round 1 samples of sediment from station SD-01R was significantly lower than that seen with sediment from the furthest upstream station, SD-00M. During Round 2, exposure to sediments from both upstream stations resulted in higher survival, 88.8 and 80.0 percent, respectively.

The results of both rounds of bioassays show evidence of toxicity in the sediments of the Pawtuxet River along the reach of and downstream of the former CIBA-GEIGY facility. Sediments from the vicinity of the Production Area showed the highest toxicity, confirming Round 1 results (Table 4). Exposure to samples from stations SD-02R, SD-02L, SD-03R and

Table 4

INTERNATIONAL TECHNOLOGY CORPORATION

**Ten-Day Acute Bioassay of Sediment Collected near the Former CIBA-GEIGY Facility
at Cranston, Rhode Island, Using Larvae of the Midge, *Chironomus tentans***

Location	Sample	Round 1 Sampling		Round 2 Sampling	
		Mean Survival ^a (%)	Standard Deviation (%)	Mean Survival ^a (%)	Standard Deviation (%)
NA	Reference	60.0	10.8	97.5	5.0
Upstream	SD-00M	65.0	23.8	NR	NR
	SD-00L	NR	NR	88.8	13.2
	SD-01R	33.8	18.9	80.0	4.1
Facility Reach	SD-02R	0.0 ^{b,c,d}	0.0	1.3 ^{b,c,d}	2.5
	SD-02L	NR	NR	0.0 ^{b,c,d}	0.0
	SD-03R	0.0 ^{b,c,d}	0.0	0.0 ^{b,c,d}	0.0
	SD-03L	NR	NR	98.8	2.5
	SD-04R	NR	NR	0.0 ^{b,c,d}	0.0
	SD-05M	NR	NR	25.0 ^{b,c,d}	7.1
	SD-05L	32.5 ^c	27.2	NR	NR
	SD-06R	0.0 ^{b,c,d}	2.0	NR	NR
	SD-07L	20.0 ^{b,c}	10.8	20.0 ^{b,c,d}	7.1
	SD-08M	0.0 ^{b,c,d}	0.0	53.8 ^{b,c}	25.6
Downstream	SD-09R	NR	NR	30.0 ^{b,c,d}	19.6
	SD-10M	28.8 ^c	8.5	NR	NR
	SD-13R	NR	NR	70.0 ^b	21.6
	SD-16L	NR	NR	43.8 ^{b,c,d}	14.9
	SD-20M	3.8 ^{b,c,d}	4.8	0.0 ^{b,c,d}	0.0

- a. Arithmetic mean of 4 chambers with 20 organisms/chamber.
b. Significantly different from reference sediment.
c. Significantly different from SD-00M (Round 1) or SD-00L (Round 2).
d. Significantly different from SD-01R.

NA - Not applicable NR - No result, test not performed.

SD-04R resulted in complete or almost complete mortality. Station SD-03L, which is located across the river from the former coffer dam and wastewater outfall and which was not sampled for bioassay testing during Round 1, was virtually non-toxic.

In the Warwick Area, between the Production Area and the Waste Water Treatment Area, Station SD-05M was the only sample collected. Exposure of *C. tentans* to this sediment caused moderate toxicity with survival of 25.0 percent, a result significantly lower than that observed for control and reference samples. This is consistent with Round 1 results from station SD-05L (Table 4).

Of the two samples collected in the vicinity of the Waste Water Treatment Area, one confirmed Round 1 results and one did not. Sediments from station SD-07L were associated once again with moderate toxicity; survival was 20.0 percent. Sediment from station SD-08M produced complete mortality in test organisms in Round 1, but 53.8 percent survival was seen in Round 2. Physical descriptions were nearly the same for the samples taken from SD-08M in the two rounds, and thus offer no explanation for the differing results.

Sediment samples collected downstream of the facility reach were about as toxic as those from the downstream half of the facility reach (SD-05M to SD-08M). The one exception to this was the furthest downstream station, SD-20M, which was associated with essentially complete mortality in both rounds of testing (Table 4).

5.0 SUMMARY

Overall, results of Round 1 bioassays were confirmed by Round 2 testing. Variability between Round 1 and Round 2 results was found at two stations, SD-01R and SD-08M. Sediments with the highest toxicity were encountered in the Production Area, with generally decreased toxicity downstream, until toxic sediments were encountered again at 1.5 miles downstream from the site.

APPENDIX A

DESCRIPTION OF METHODS

APPENDIX A

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1.0 CULTURING OF TEST ORGANISMS

All organisms used in toxicity tests were cultured at IT's bioassay laboratory in Edison, New Jersey. Continuous culturing in-house allows the bioassay laboratory to monitor and document the life history of the test organisms and the cultures from which they are obtained and to provide a ready and consistent test species.

Larvae of the midge, *C. tentans*, to be used for bioassay testing were cultured following the procedure of Nebecker et al. (1984). Cultures were contained within 10 gallon glass aquaria aerated by oil-free air lines and maintained at $24\pm 2^{\circ}\text{C}$. Weekly renewals of water were made with moderately hard reconstituted water (Peltier and Weber, 1985) to which crushed paper towels were added as needed to act as a substrate. Animals were fed *ad libitum* on a diet of pulverized cereal leaves and Tetramin® flakes. Adult midges were removed from the culture aquaria using an aspirator and were placed in a 5 L glass breeder aquarium which contained moderately hard reconstituted water, cereal leaves, and *Selenastrum capricornutum*, an alga cultured to provide food for newly hatched larvae. Larvae were maintained within this aquarium until the initiation of testing.

2.0 SAMPLE COLLECTION AND HANDLING

2.1 SELECTION OF SAMPLING SITES

Collection of sediments at the site was conducted by personnel from Normandeau Associates, Inc., Woodward-Clyde Consultants, Inc., and IT. Dates of sample collection are listed in Table A-1. All stations for collection of sediments were located in the Pawtuxet River in Cranston or Warwick, Rhode Island, through an area ranging from approximately 0.3 miles upstream to 0.7 miles downstream of the former CIBA-GEIGY facility. Samples of sediment within the facility reach were collected at points where maximum concentrations of toxicants might have been expected, due either to activities at the site or to the dynamics of the river, and at points which would aid in determining extent of contamination. Samples upstream and downstream of the former facility were selected because they were at pronounced meander bends or at other areas

Table A-1

**Dates of Collection of Bioassay Samples of Sediment from the Pawtuxet River in the
Vicinity of the Former CIBA-GEIGY Facility at Cranston, Rhode Island**

Collection Date	Sample Location
28 March 1991	SD-00L
28 March 1991	SD-01R
26 March 1991	SD-02R
26 March 1991	SD-02L
28 March 1991	SD-03R
27 March 1991	SD-03L
27 March 1991	SD-04R
28 March 1991	SD-05M
28 March 1991	SD-07L
27 March 1991	SD-08M
27 March 1991	SD-09R
27 March 1991	SD-13R
29 March 1991	SD-16L
29 March 1991	SD-20M

likely to afford sediment.

2.2 DESCRIPTION OF THE SAMPLING LOCATIONS

Approximate locations of sampling points are shown in Figures 1 and 2. Stations SD-00L and SD-01R are both upstream of the site. These were chosen as reference stations outside of and before any influence by the site. Station SD-00L is located approximately 0.3 mile upstream of the facility reach, at the first sharp bend in the Pawtuxet River upstream of the site. This station was located at the second sharp bend upstream from the site in Round 1, but the location was changed for Round 2 because sediment was more available at the first bend. Station SD-01R is located immediately upstream of the site and just downstream from the confluence of the Pawtuxet River with a creek that flows from Bellefont Pond. Station SD-01R is close to the Atlantic Tubing and Rubber Company. Sediment was collected near the north bank of the river. For this station and for others which were sampled in both Round 1 and Round 2, every effort was made to collect the Round 2 sample from the same location as Round 1.

Stations SD-02R and SD-03R are located in the Pawtuxet River, off the Production Area bulkhead and across the river from the western portion of the Warwick Area. Station SD-02R is located in the vicinity of a former over-the-river tank farm, just downstream of the western extent of the facility reach. Station SD-03R is located immediately downstream of the location of the former coffer dam and wastewater outfall, just upstream of the automobile and railroad bridge connecting the Production Area and Warwick Area. Stations SD-02L and SD-03L are located across from SD-02R and SD-03R, respectively, on the Warwick Area side. Station SD-04R is located off the north bank of the river just downstream of the automobile and railroad bridge at the furthest downstream extent of the Production Area.

Station SD-05M is located midstream in the Pawtuxet River off the mid-portion of the Warwick Area near the foot of Mayflower Drive. Station SD-05L was sampled in Round 1, but this was changed for Round 2 because sediment was more available at SD-05L. Stations SD-07L and SD-08M are located in the Pawtuxet River off the Wastewater Treatment Area and the eastern portion of the Warwick Area. Station SD-07L is located just off the south bank on the Warwick

Area side, across from the middle portion of the Wastewater Treatment Area. Station SD-08M is located midstream in the river, just upstream of the eastern extent of both the Wastewater Treatment Area and the Warwick Area.

Stations SD-09R, SD-13R, SD-16L, and SD-20M are located downstream of the former CIBA-GEIGY facility. Station SD-09R is located off the north bank of the river, just downstream of the former CIBA-GEIGY facility but still upstream of the Warwick Avenue bridge. Stations SD-13R and SD-16L are located approximately 0.3 mile and 0.4 mile downstream of the site, respectively, near meander bends in the river. Station SD-20M is located approximately 0.7 mile downstream of the site at a sharp bend in the river, near a local ballroom known as "Rhodes on the Pawtuxet." The river is wider and shallower at SD-20M than at any other sampling location. SD-20M was the only downstream station sampled in both rounds.

2.3 SAMPLE COLLECTION

Samples were collected during the week of 25 March 1990. The dates of collection of individual samples are shown in Table A-1. The week of collection followed a period of rain. The water level of the Pawtuxet River was approximately one foot higher than during Round 1 sampling. Water flow was also faster during Round 2 sampling, compared with Round 1.

A Ponar grab sampler was used to collect samples of sediment. Two or more grabs were required to provide sufficient sediment for toxicity testing. Sediment samples were placed in 7 gallon polyethylene bags within 5 gallon polypropylene buckets. The bags were sealed and maintained on ice during holding and transport to the bioassay laboratory. All samples were stored at the bioassay laboratory in a refrigerator maintained at approximately 4°C.

2.4 SAMPLE HANDLING AND PREPARATION

Sediments were removed from cold storage on 1 April 1991 and decanted. The sediments were then stirred with a PVC rod and filtered through an ASTM Standard No. 18 sieve with 1 mm openings to remove large particles and endemic animals, especially predators. Sieving of sediments was performed without the introduction of additional water. Sieved sediment samples

were stored in the dark at approximately 4°C until the initiation of testing.

3.0 TEST METHODOLOGY

All bioassay tests were conducted on undiluted sediment samples. The ten day bioassays on sediment using *C. tentans* were based on IT Testing SOP D2.0, which is attached as Appendix B. IT's procedure is modeled on those of Nebecker et al. (1984) and Weber et al. (1989). Second instar larvae of *C. tentans* were used in the solid-phase bioassays. Each sieved sediment sample was mixed, and 200 ml aliquots were placed in four replicate 1 L glass beakers. Each beaker was brought to a volume of 1 L with 800 ml of water from Round Valley Reservoir, New Jersey. This water was introduced gently by pouring it slowly down the side of the test beakers. These beakers were then randomly placed in the test area and the sediments were allowed to settle overnight. A tongue depressor was attached with a rubber band to the exterior of each beaker, rising vertically past the top of the beaker. To the tongue depressor was attached an air line and a Pasteur pipet, the tip of which extended 2-4 cm below the surface of the water. Gentle aeration was begun approximately 30 minutes before introduction of the organisms to the test chambers.

Organisms from the holding tank were randomly chosen and transferred gently with forceps to 2 ounce plastic weighing boats, 20 organisms per boat. The organisms were then transferred to the test beakers by submerging the boats in the water, allowing the chironomids to slide out of the boats. Any organism observed floating on the surface after introduction to the test chambers was gently drawn into a wide-bore pipet and reintroduced under the water surface. After ten days of exposure, the test was terminated. The sediments were passed through ASTM Standard No. 18 sieves. Surviving organisms were retained on the sieves and counted to complete the test.

4.0 STATISTICAL METHODS

Statistical analyses were conducted on the mean percent survival for each station sampled. The χ^2 goodness-of-fit test was used to compare sets of observed data with expected frequencies of

occurrence to determine if the observed data were normally distributed. Homogeneity of variance across samples was determined using Bartlett's Test. Following confirmation of normality and homogeneity, survival data from the bioassays were analyzed using Dunnett's Procedure. The mean percent survival of organisms exposed to test sediments was compared to the results following exposure to a reference sediment or to either of the sediments from the two upstream locations, SD-00L and SD-01R. The significance level was set at $\alpha = 0.05$.

6.0 REFERENCES

1. Nebecker, A. V., Cairns, M. A., Gakstatter, J. H., Malleg, K. W., Schuytema, G. S. and Krawczyk, D. F. (1984), "Biological methods for determining toxicity of contaminated freshwater sediments to invertebrates," *Environmental Toxicology and Chemistry*, 3:617-630.
2. Peltier, W. H. and Weber, C. I., Eds. (1985), "Methods for measuring the acute toxicity of effluents to freshwater and marine organisms," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH, EPA Publication No. EPA/600/4-85/013, 216 pp.
3. Weber, C. I., Peltier, W. H., Norberg-King, T. J., Horning, W. B., Kessler, F. A., Menkedick, J. R., Neiheisel, T. W., Lewis, P. A., Klemm, D. J., Pickering, Q. H., Robinson, E. L., Lazorchak, J. M., Wymer, L. J., and Freyberg, R. W. (1989), "Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms," 2nd Ed., U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH, EPA Publication No. EPA/600/4-89/001, 249 pp.

APPENDIX B

**STANDARD OPERATING PROCEDURE FOR
TEN-DAY ACUTE WHOLE SEDIMENT BIOASSAY
WITH *Chironomus tentans***

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**D2.0 10-DAY STATIC ACUTE WHOLE SEDIMENT BIOASSAY
WITH Chironomus tentans**

D2.1 OBJECTIVE

This test is designed to assess the acute toxicity of whole sediments to larvae of the midge, Chironomus tentans.

D2.2 HUSBANDRY

D2.2.1 Midge larvae will be cultured at IT Corporation (IT), Edison, New Jersey, according to accepted practices as outlined below. A full record of all activities relating to culture of midge larvae will be kept on file. These procedures are adapted from Nebecker, 1984.

D2.2.2 Midge larvae will be raised in static 10-gallon all-glass aquaria. All aquaria will be artificially aerated through a built-in air blower system which provides air for all culture and test systems. The culture tanks will be maintained at 22 degrees C, and will not be allowed to vary more than two degrees in any 12-hour period. Weekly renewals of culture water will be made with moderately hard reconstituted water. Crushed paper towels will be added as needed for substrate. Animals will be fed ad libitum on a diet consisting of pulverized cereal leaves and Tetra® flakes.

D2.2.3 Water quality parameters of hardness, alkalinity, dissolved oxygen, pH, conductivity, and temperature will be made on a weekly basis.

D2.2.4 When larvae are required for a test, adult midges will be removed from culture aquaria via an aspirator and placed in 5-liter all-glass breeder aquaria filled to 1 cm with reconstituted water. Eggs will be transferred to aerated

aquaria containing reconstituted water, cereal flakes, and cultured algae.

D2.3 SAMPLE COLLECTION AND HOLDING

D2.3.1 Sediment samples for testing shall be obtained no longer than 30 days prior to the start of the test, and will be stored at 4 degrees C until needed.

D2.3.2 Enough sediment for the entire test shall be obtained at the same time. To remove debris and predators, samples should be passed through a screen with openings no larger than 1 mm in size (Nebecker, 1984; Cairns, 1984). If possible, this procedure should be completed on site, using site water to aid in sifting. Sifted samples will be stored in clean polyethylene containers. Custody of samples shall follow IT standard procedures.

D2.4 CONTROL SEDIMENT

D2.4.1 A suitable control sediment will be used for each test. Control sediment will be collected from clean watersheds according to the same methods as test samples. Each batch of sediment will be tested for larval survivability prior to use in toxicity tests. Any batch which does not encourage greater than 90 percent survival of second instar larvae for ten days upon retest shall be discarded.

D2.4.2 In the event that regulatory agencies require, or it is deemed necessary by IT for the validity of a test, clean reference sediments shall be obtained from the general location of the test sampling.

D2.5 TEN-DAY ACUTE BIOASSAY

Ten day acute static sediment bioassay shall be conducted according to

methodologies recommended by Nebecker, 1984.

- D2.5.1 A minimum of three replicate chambers of each sample will be compared to three replicate chambers of control sediment.
- D2.5.2 Test chambers shall consist of acid washed one-liter borosilicate glass beakers. Each chamber will be aerated with a glass tipped pipette held above the sediment and at a rate slow enough to ensure the sediment is not unduly disturbed.
- D2.5.3 Sample slurry will be added to each chamber to approximately 300 ml. If this does not provide at least 200 ml of substrate, more slurry will be added. The remainder of the beaker will be filled with moderately hard reconstituted water. Each chamber will be allowed to settle for 24 hours prior to introduction of test organisms.
- D2.5.4 At the time of set-up, a subsample of sediment slurry will be taken for testing. Percent organic matter and particle size analysis can be conducted on each sample, if requested.
- D2.5.5 At the start of the test, 20 second instar midge larvae (Chironomus tentans) will be randomly selected from culture aquaria using a glass pipette. Only larvae of equal size and exhibiting normal vigor will be used in toxicity tests.
- D2.5.6 Initial and final test conditions will be measured using standard IT laboratory procedures and will include dissolved oxygen, pH, conductivity, alkalinity, hardness, and temperature. Dissolved oxygen and temperature will be monitored daily.
- D2.5.7 The test will be conducted at 20 +/- 2 degrees C. Photoperiod will be 16 hours light / 8 hours dark.
- D2.5.8 Organisms will not be fed during the test unless the percent

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organic matter of sediment is less than 5 percent ash-free dry weight (Nebecker, 1986). If feeding is required, 0.2 grams of Tetra® flakes will be added to each test chamber at the start of the second day and again on day 7. Feeding will be reduced or discontinued if fungus is observed.

D2.5.9 Water lost to evaporation will be replenished as needed with moderately hard reconstituted water. This water will be added as slowly as is required to ensure the sediment is not disturbed.

D2.5.10 At the completion of the test, the chambers will be drained to 300 ml and this water discarded. The sediment will be sifted through a 0.5-1 mm mesh screen and counts made of surviving larvae. Larval length and wet weight can be recorded, if requested.

D2.6 DATA INTERPRETATION

Data will be checked for normality and if assumptions are met, will be analyzed with Tukey's test for two samples. Should normality not be obtainable, the non-parametric Mann-Whitney U Test for comparing two samples will be utilized (Sokal and Rohlf, 1981). Significant difference from controls at an $\alpha \leq 0.5$ will be considered to indicate toxicity.

D2.7 QUALITY ASSURANCE/QUALITY CONTROL

All phases of testing shall be audited according to IT standard QA/QC procedures.